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July 15, 2004

Mr. Roy Crossland
START Project Officer
U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, Kansas 66101

Subject: **Lead Trend Analysis**
Herculaneum Lead Smelter
U.S. EPA Region 7 START 2, Contract No. 68-S7-01-41, Task Order No. 0027
Task Monitor: Bruce Morrison, On-Scene Coordinator

Dear Mr. Crossland:

Tetra Tech EM Inc.(Tetra Tech) is submitting the attached Lead Trend Analysis report for the Herculaneum Lead Smelter site. Tetra Tech has revised the trend analysis to include the most recent analytical data from sampling round 17 based on conversations with the EPA task monitor. If you have any questions or comments, please contact the Tetra Tech project manager at (913) 495-3908.

Sincerely,

David Homer
Project Manager

Hieu Q. Vu, PE, CHMM
START Program Manager

cc: Bruce Morrison, EPA

Enclosures

G9011/0027

LEAD SOIL TREND ANALYSIS
THROUGH JUNE 2004
Herculaneum Lead Smelter Site
Herculaneum, Missouri

Tetra Tech EM Inc. (Tetra Tech) was tasked by the U.S. Environmental Protection Agency (EPA) Region 7 Enforcement/Fund Lead Removal program to conduct a trend analysis of soil lead concentrations at selected locations within Herculaneum, Missouri (City). Specifically, the Tetra Tech Superfund Technical Assessment and Response Team (START) 2 was requested to review and analyze data that would enable EPA to determine if soil lead concentrations were increasing over time at a variety of locations within the City. Tetra Tech had previously performed this analysis and was requested to repeat the analysis using the most current sampling data. The assessment was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the Superfund Amendments and Reauthorization Act of 1986. The project was assigned under START Contract No. 68-S7-01-41, Task Order No. 0027.

Tetra Tech focused its analysis on one data set called "Recontamination." This data set includes results from a number of locations. The data were collected from four different quadrants at each property, and several properties also included samples from a driveway area. Lead concentrations were estimated at each location at approximately monthly intervals from the time removal activities were completed until June 2004 (sampling round 17). Due to the sequence of removal activities, not all properties had the same number of sampling events; the number of events ranged from 4 to 11 events per residence. At many locations, some intervals within the series were omitted due to weather or access restrictions. The lead concentrations were determined by use of a portable X-ray fluorescence (XRF) instrument. Samples were collected and analyzed in accordance with the quality assurance project plan (QAPP) dated September 11, 2001.

This document presents the methods used to evaluate changes in lead soil concentrations following the removal activities and the results of this analysis.

Methods

Temporal trends in lead concentrations for 21 properties are summarized in Table 1. Trend tests were conducted for each property using all data collected from round 7 (August 2002) through round 17

(June 2004). The non-parametric Mann-Kendall test was used to evaluate temporal trends for individual properties. The Mann-Kendall test is a widely used statistical test for detecting monotonic trends (that is, trends that are either increasing or decreasing) in time-series of data (Gilbert 1987; Helsel and Hirsch 1992; Gibbons 1994). Because the Mann-Kendall test uses only the relative magnitude of the data rather than their measured values, it has a number of desirable properties: the data do not need to be normally distributed; and the test is not significantly affected by outliers, missing data, or censored data. Censored data are normally treated in the Mann-Kendall test by setting all non-detect values to a concentration slightly below the minimum detected concentration. However, because this analysis was conducted for pooled measurements from each of the four quadrants for each property, only the median concentrations for each sampling round were considered. Each median value was effectively treated as a detected measurement for the purpose of this analysis. It should be noted that a minimum of four sampling events are required to perform this test, so properties with fewer than four rounds of sampling were not evaluated.

Results

The analysis of temporal trends in lead concentrations identified six properties with a statistically significant trend; House Numbers 20, 5, 22, 9, 16, and 8. All locations except House Numbers 16, 9, and 8 were within 0.25 miles of the smelter. House Numbers 9 and 16 are approximately 0.5 miles from the smelter, and House Number 8 is approximately 1.0 miles away. The data analysis from the previous sampling round showed four homes with an increasing trend. Based on the most current results, House Numbers 9 and 16 now exhibit a statistically significant increasing trend in lead concentrations not observed during the previous data analysis.

References:

Gibbons, R. D. 1994. *Statistical Methods for Groundwater Monitoring.* John Wiley & Sons, Inc. New York, New York.

Gilbert, R. O. 1987. *Statistical Methods in Environmental Pollution Monitoring.* John Wiley & Sons, Inc. New York, New York.

Helsel, D. R. and R. M. Hirsh. 1992. *Statistical Methods in Water Resources.* Elsevier. New York, New York.

TABLE 1
RESULTS OF STATISTICAL TESTING FOR MONOTONIC TRENDS (MANN-KENDALL TEST) IN LEAD CONCENTRATIONS
SAMPLING ROUNDS 7 THROUGH 17
HERCULANEUM LEAD SMELTER SITE - HERCULANEUM, MISSOURI

Distance From Smelter[1] (miles)	House Number	Address	Number of Sampling Events[2]	Sampling Event		Test Statistic (S)	Probability > S	Trend Significant?[3] (Yes/No)	Direction of Trend
				First	Last				
0.10	76		4	10/30/2003	06/22/2004	2	0.38	No	N/A
0.20	20	928 Church	10	08/26/2002	06/21/2004	31	0.00	**Yes**	**Increasing**
0.25	5	407 Burris	10	08/26/2002	06/22/2004	35	0.00	**Yes**	**Increasing**
0.25	6	907 Dale	10	08/23/2002	06/21/2004	17	0.08	No	N/A
0.25	22	824 Brown	9	08/26/2002	06/22/2004	20	0.02	**Yes**	**Increasing**
0.25	24	812 Brown	8	11/07/2002	06/22/2004	12	0.09	No	N/A
0.40	12	292 Park	11	08/23/2002	06/21/2004	18	0.17	No	N/A
0.40	13	562 Reservoir	7	08/23/2002	06/23/2003	3	0.39	No	N/A
0.40	17	416 Thurwell	10	08/22/2002	06/21/2004	19	0.05	No	N/A
0.40	21	295 Broadway	6	08/23/2002	03/23/2004	5	0.24	No	N/A
0.45	11	525 Joachim	5	08/26/2002	03/17/2003	0	0.59	No	N/A
0.50	14	440 Thurwell	5	09/16/2002	06/23/2003	-2	0.41	No	N/A
0.50	16	695 Joachim	8	09/16/2002	06/21/2004	17	0.02	**Yes**	**Increasing**
0.50	19	407 Hill	10	08/22/2002	06/21/2004	7	0.30	No	N/A
0.54	9	454 Hill	10	08/22/2002	06/21/2004	21	0.04	**Yes**	**Increasing**
0.60	4	438 Washington	6	08/22/2002	03/14/2003	2	0.43	No	N/A
0.60	18	422 Reservior	11	08/23/2002	06/21/2004	17	0.18	No	N/A
0.75	3	441 Main	11	08/23/2002	06/21/2004	18	0.17	No	N/A
0.75	10	485 St. Joseph	6	08/22/2002	03/14/2003	2	0.43	No	N/A
0.75	23	404 Jefferson	4	10/08/2002	01/13/2003	3	0.27	No	N/A
0.80	7	434 Sherman	11	08/23/2002	06/21/2004	19	0.15	No	N/A
1.00	8	157 Joachim	6	08/23/2002	03/17/2003	13	0.01	**Yes**	**Increasing**

Notes:

[1] Properties are ordered as a function of increasing distance from the smelter.

[2] Trend tests were not conducted for properties with fewer than four rounds of sampling.

[3] Monotonic trends are significant for probabilities less than or equal to 0.05; significant negative values for the Mann-Kendall test statistic indicate that trends are decreasing; and significant positive values for the Mann-Kendall test statistic indicate that trends are increasing

NA No significant trend identified.